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THE JOURNAL OF SCIENTIFIC  
ILLUMINATION.

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OFFICIAL ORGAN OF THE  
**Illuminating Engineering Society.**  
(Founded in London 1909.)

This number contains the Discussion on  
**"Women in Industry"** opened by **Mr.  
Granville H. Baillie** (Chief Technical  
Adjudicator, D.A. Section, Ministry of Munitions  
of War) at a Meeting of the Circle of Scientific,  
Technical, and Trade Journalists on May 24th,  
1917.

*Other matters dealt with include :*

WOMEN IN ILLUMINATING ENGINEERING—INDUSTRIAL  
RESEARCH IN THE UNITED STATES OF AMERICA—  
FLUORESCENCE AND PHOSPHORESCENCE, &c.

ILLUMINATING ENGINEERING PUBLISHING COMPANY, LTD.,  
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Tel. No. 5215 Victoria.

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## EDITORIAL.

### **Women in Industry.**

In this number we give a full account of the discussion at the meeting of the Circle of Scientific, Technical and Trade Journalists on May 22nd, when a discussion on "Women in Industry" was opened by Mr. Granville H. Baillie (Chief Technical Adjudicator, D.A. Section, Ministry of Munitions).

The object of this discussion was to survey the work of women in industry, to gain information as to the duties for which they are best fitted, and the precautions that have to be observed in various vocations in order to obtain the most efficient results. The subject is one of immense importance both in regard to the present emergency and with a view to the future. The field for discussion thus outlined is a very wide one without



entering into controversial matters such as wages, trade union regulations, etc.

The Circle was privileged to hear the views of a number of ladies and gentlemen responsible for the organisation of women's work, both in munition factories and in non-munition industries. There can, of course, be only one opinion regarding the magnificent way in which women have risen to the present emergency, and to many people the adaptability they have shown in taking up new fields of employment has been a revelation.

It is therefore natural that our minds should turn to the important problem of the best fields of employment for women, especially women of the more highly educated type, after the war is over. Miss Anderson (H.M. Chief Lady Inspector of Factories) dealt in a most sympathetic way with this question, pointing out that the utilisation of women in many industries should be regarded as supplementary to the labour of men, rather than as a permanent alternative, and indicating the desirability of finding opportunities of service which are congenial and suitable. The view was very generally expressed in the discussion that women are better fitted for occupations that demand deftness of hand rather than heavy muscular effort and constant strain. From experience obtained in chemical and explosives factories it may also be inferred that women, under proper supervision, show coolness in emergency as well as diligence and painstaking attention to detail. There should be good opportunity for the exercise of these qualities in many new fields of industry which will doubtless develop in this country after the termination of the war. In those processes which involve skilful manipulation, for example in the great textile industries, women will continue to be employed and, as Miss Monkhouse suggests, the better educated type of women would be of considerable value as lady supervisors, wherever female labour is employed on a large scale.

There are also many varieties of work, such as those concerned with the preparation of foodstuffs, clothing, laundry and millinery, which fall naturally within the woman's sphere, and we expect to see them more fully employed in all those businesses which bear directly on the comfort of the home, the care of children, and the public health. As doctors, factory and sanitary inspectors their co-operation is essential in dealing with the women's aspects of hygiene.

We also believe that educated women could, with advantage, take a fuller share in many varieties of scientific work, and we notice in the Annual Report of the National Physical Laboratory, and from Mr. Fleming's contribution referring to the experience of the British Westinghouse Electric and Manufacturing Co., Ltd., that in a considerable number of cases graduates of women's colleges have successfully undertaken work of this kind.

### **Women in Illuminating Engineering.**

One field of work which seems to us particularly suited to women is to be found in the various forms of service covered by the term "illuminating engineering." In a very large section of the work, both in the manufacture of lamps and lighting appliances and in the distribution and application of light, the qualities which women usually possess would find an admirable outlet. Their deftness of hand had made them indispensable, even before the war, in factories devoted to the manufacture of electric lamps and incandescent mantles. The work involved in the making of fittings is also very largely of a light character which women could do, and the same applies to the making of optical instruments.

When we turn to the wider field of the applications of light in practice we find again many opportunities for the services of women. They have often gifts of tact and personality that render them very suitable for salesmanship or for duties which bring them into direct contact with the consumer. Their services in this direction could with advantage be more extensively used by gas and electric supply companies as canvassers, lecturers, and in the showroom.

In the case of gas companies, which are concerned not only with gas supply but with the maintenance of installations, the value of the assistance of women was widely recognised even before the war, and since then they have been found equal to the most varied duties. Inspection and maintenance are now very largely undertaken by women, and the writer can testify to the expertness and thoroughness which they bring to bear on the renewal of mantles and care of chimneys and globes. As demonstrators of gas lighting, heating and cooking, women of the right type have also done very well.

In the domestic field they have a unique advantage, for it is common knowledge that in the average home the lighting conditions are very largely—one might almost say invariably—determined by the lady of the house. Shades are selected to harmonise with the decorations, in general selected by the lady, and lamps must be located to suit domestic needs which are essentially under her supervision. An intelligent woman, one may safely say, is in a specially good position to appreciate the lighting requirements in a drawing room, bedroom, kitchen or any other part of the home. Through the services of women, therefore, we find the most hopeful means of solving that exceedingly difficult problem—the presentation of illuminating engineering principles in a form acceptable to the average non-technical consumer.

But the opportunities for women's services in connection with illuminating engineering do not stop here. Women already undertake the greater

part of instruction in elementary and secondary schools, and already play a not inconsiderable part in municipal affairs. Their services might therefore be enlisted in the work of providing proper lighting facilities in school-rooms. Moreover, the very fact of their having so much to do with the education of children makes them potent instruments for moulding the public opinion of the future in regard to lighting matters. Already it is the duty of teachers in schools to instil in the minds of children elementary principles of cleanliness and hygiene. In the same way children should be taught early the benefits of good lighting so that, to the next generation, the sight of broken mantles, dust-obscured bulbs and shades, and badly situated glaring lights will be as abhorrent as an insanitary and ill-kept home.

The same considerations apply to factories, where women already play a great part and will probably exert even more influence in the future, as inspectors, welfare workers, and superintendents. Similarly in the medical profession and in matters of public health women's influence in favour of proper illumination will be strongly felt. In all these cases their influence might be exerted.

In the case of the more highly educated women, we see no reason why they should not be able to do very good service as independent lighting experts. It has been increasingly recognised of late years that they have opportunities for advising on the choice of furniture and decoration, and supervising the fitting up of private houses. With their natural gifts in this direction might be combined the study of lighting problems. Illuminating engineering, after all, does not involve any technical study beyond the grasp of the well-educated woman. To a college graduate the recognition of the characteristic qualities of different types of lamps and reflectors, and the calculations entailed in light-distribution would present no serious difficulties.

Illuminating engineering, we have often pointed out, is not only a matter for the technical expert in lamps and lighting appliances. It is an essential element in domestic life and a matter vital to the health and well-being of the nation as a whole—of equal consequence to women and men.

It was for this reason that membership in the Illuminating Engineering Society was, from the formation of the Society onwards, opened to men and women alike. We hope that many ladies will join the ranks of the Society and take their share in the illuminating engineering movement.\*

LEON GASTER.

\* See Form of Application and Particulars on opposite page.



# The Illuminating Engineering Society.

(Founded in London, 1909.)

ANNUAL SUBSCRIPTION, ONE GUINEA.

All Communications should be addressed to:—

L. GASTER, Hon. Sec.,  
32, Victoria Street, London, S.W.

## Application for Membership.

The members of this Society shall be designated Members, Honorary Members, and Corresponding Members.

A Member may be anyone interested in the objects of the Society, but at the date of election shall not be less than twenty-one years of age.

Ordinary, Honorary, and Corresponding Members, may be of either sex and of any nationality.

An application for admission to the Society shall be made in a form prescribed by the Council, and shall refer to at least two Members of the Society; or if an applicant certifies that he is not personally known to two members, references may be accepted to Members of professional societies of good standing, or to other persons whose good standing may be readily verified by the Council. If, in the opinion of the Council, further support for a Member's candidature be considered necessary, the recommendations of four existing Members shall be deemed sufficient; but the final consideration of a nomination for membership rests with the Council. (Extract from Constitution, see *Illuminating Engineer*, Lond., June, 1909, p. 377-382).

*We hereby recommend:—*

Name.....

Address.....

Occupation, &c.....

Here state name in full, date and place of birth, rank, profession or business, usual place of residence and qualifications for membership of the candidate.

Date and Place of Birth.....

as a fit and proper person to become a member of the Illuminating Engineering Society.

\*Here must follow the names of two or more nominators, one of whom must have personal knowledge of the candidate.

Date.....

Nomination approved by Council.....

Date of Announcement of Nomination.....

Date of Election.....

This portion to be filled up by Council.

## The Illuminating Engineering Society.

(Founded in London, 1909.)

### Abstracts from Constitution and Bye-Laws.

#### NATURE AND AIMS OF THE ILLUMINATING ENGINEERING SOCIETY.

The name of this Association shall be the Illuminating Engineering Society.

Its objects shall be the advancement of the theory and practice of illuminating engineering and the dissemination of knowledge relating thereto. Among the means to this end shall be meetings for the presentation and discussion of appropriate papers; the publication as may seem expedient of such papers, of discussions and communications; and through committees, the study of subjects relating to the science and art of illumination, and the publication of reports thereon.

Also the organization of, or participation in periodical national and international exhibitions of developments in illumination, and congresses dealing with the subject.

#### PUBLICATION OF PROCEEDINGS, &c., OF SOCIETY.

*The Illuminating Engineer*, published by the Illuminating Engineering Publishing Co., Ltd., in London, shall be the recognized official organ of the Society.

#### CO-OPERATION WITH OTHER INSTITUTIONS, &c.

The Council shall be at liberty to approach or to entertain and, if desirable, accept overtures from other Societies and Institutions with a view to joint discussions of subjects of mutual interest, exchange of transactions, and co-operation to secure Governmental action, for the advancement of the objects of the Society.

#### FEES AND SUBSCRIPTIONS.

The annual subscription (one guinea) is payable in advance. Applications for subscriptions shall be sent out quarterly by the Hon. Secretary.

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I, the undersigned, desire to become a Member of the Illuminating Engineering Society, and hereby promise that, if elected, I will submit and conform in all respects to, and be governed by, the terms and provisions of the Constitution and the Bye-Laws made in pursuance thereof; provided that whenever I shall signify in writing to the Hon. Secretary that I am desirous of ceasing to be a Member thereof, I shall be free from this obligation, after payment of any Annual Subscription or arrears which may be due from me at that period.

Signature of Candidate.....

Date.....

## WOMEN IN INDUSTRY.

(Discussion at a meeting of the Circle of Scientific, Technical and Trade Journalists held at the Hall of the Institute of Journalists, London, at 5 p.m., on May 24th.)

A MEETING of the Circle of Scientific, Technical and Trade Journalists took place on May 24th as stated above, Mr. L. Gaster in the chair.

The CHAIRMAN, in opening the proceedings, said that the subject for discussion was of extreme present importance and of great moment for the future. Mr. Granville H. Baillie, who had special experience of women's work in munition factories, had kindly accepted the invitation to address the Circle, and tell them something of the problems encountered in this branch of work. They were also honoured by the presence of experts in other fields who would deal with the employment of women in non-munition factories and other fields of industry. They had therefore a unique opportunity of comparing the information available from many different sources regarding the position of women in industry.

It was very necessary to know in what directions women had shown themselves specially gifted, what limitations and restrictions were necessary, and what precautions had to be taken in regard to women's labour. Everyone admired the part played by women since the outbreak of war, their resolute disregard of hardship, and the devotion which had led them to put forth their utmost effort in the present emergency. But it must be remembered that some of these efforts which might be made without injury for a short time ought not to be prolonged without thoroughly examining the effects produced on the health and welfare of the operators.

In the meantime it would be very helpful if information could be collected regarding the occupations for which women were best suited, and in which they could successfully participate in the future. There were many processes, such as those involved in the great textile industries and the making of electric

glow lamps and incandescent mantles, &c., where women's deftness of hand and manipulative skill had proved valuable even before the war. After the war the most hopeful fields of extension for the occupation of women would lie in such processes. Another important matter for consideration was the desirable training and the suitable employment of the more highly educated women, as accountants, dispensing chemists, doctors, and largely for chemical and other scientific research work.

In conclusion, Mr Gaster said that it was not their object, in this discussion, to enter upon the political and controversial aspects of women's labour. Their intention was to elicit the facts in regard to the present position of women in industry, to find out the kind of work they were best fitted to do, and the precautions which would be necessary in the continuance of such work in the future.

It was very important for technical journalists to be well informed on these points so that the matter could be discussed in a scientific and impartial spirit and the true facts of the position correctly presented.

The CHAIRMAN then called upon Mr. G. H. Baillie to open the discussion.

MR. GRANVILLE H. BAILLIE (Chief Technical Adjudicator, D.A. Section, Ministry of Munitions of War), in opening the discussion, said that the "Dilution of Labour" came into being as a phrase in October, 1915, but the actual process had existed before it was christened. The more progressive of our manufacturers had already diluted their skilled labour up to the narrow limits then fixed, but so little had been done that the immense results that have now been achieved may fairly be attributed to the campaign of dilution that was initiated by the Ministry of Munitions. The first

step in that campaign was an agreement known as the Treasury Agreement, made in March, 1915, with certain trades unions. Under this, the unions agreed to relax all practices tending to restrict production in consideration of certain conditions and pledges. The second step in the campaign was the distribution in October of the same year of a circular to controlled firms calling upon them to dilute their skilled labour, and the third step was the appointment of a body of engineers known as "dilution officers," to visit all firms and assist them to carry out the injunctions in the circular. The results of that campaign were shown better than he or anybody could describe them in the exhibition of women's work held at the Royal Colonial Institute, which was so successfully organised by the Ministry recently. The majority of technical journalists had probably seen that exhibition, and he felt sure that to anyone possessing sufficient technical knowledge to appreciate what he saw, that exhibition must have been an absolute revelation. Mr. Kellaway in opening the exhibition described very forcibly what dilution by women's work had done for the country, and his speech might fairly be summed up by saying that it had made all the difference between defeat and victory. In one respect that exhibition might be misleading. It showed that women were making nearly the whole of aeroplane engines, were grinding gauges to very close limits of accuracy, and were doing all the machining operations of the breech mechanisms of guns, and it might lead to the view that dilution by women's work had nearly reached its end. That was very far from being the case; even if no fresh field of work were touched it would be years before dilution was complete. The fact was that that exhibition was not a show to interest the public or to prove the wonders that the Ministry and employers had done. It had a definite educational purpose. The samples of work that were shown there were not samples of work that were being done by women throughout the country. They were samples of the best work done in certain of the more progressive firms, and they were brought together in that exhibition to serve as an object-lesson to other firms

that had done less well, and those were, in fact, the majority of the firms in the country. Many of them were making every endeavour to dilute, but for one reason or another they remained behind. Others were indifferent, and the results they got were indifferent, but there were still others who were too proud to dilute, who said they had run their works for thirty years without a woman in the place and as long as they were in charge they would not have women in the place. The work of the Ministry was to help the willing, to convert the unbelieving, and to urge the unwilling. It was an immense task, and it was impossible to overrate its importance. It was a task in which the technical press could take a part, and a very important part. He would return to that later. For the moment he would discuss the question of what dilution was, because its real meaning was not always appreciated.

The question even now was often put, "How can a woman after a few weeks' training replace a skilled man who has taken five years to learn his job?" The answer to that was that she did not replace the skilled man in the sense of being his equal as an asset in the shop. Nevertheless, she might take his place at a particular bench or a machine without any loss of output. That was secured by reorganisation of work to make it suitable for women after a short period of training. This reorganisation of work constituted the main part of dilution. He would give an actual example, which was interesting as being about the simplest engineering job one could imagine, viz., drilling the small holes in fuses. Normally that work would be done by skilled drillers who would grind their drills, fix them and the fuse in the machine and operate the machine to drill the hole. With the high accuracy that the work required it was not by any means an easy job, and it would take a long training for a woman to tackle it. The procedure to effect dilution was as follows: The work is split up into three parts. Part 1 is grinding the drills; that is a skilled job. Part 2 is setting the drill and the work in the drilling machine so that the hole might be drilled in the right place and in the right direction and to the right depth; that entails measurement to fine

limits and is also skilled work. Part 3 is pulling down the lever of the drilling machine, and that requires no skill, but only a certain amount of experience to be able to make the hole as quickly as possible without breaking the drill. Supposing there were originally ten skilled drillers and ten machines, the first step in dilution would be to put on ten women to do the last part of the job, *i.e.*, operating the machine. No training is required; they could start work at once, only for a few days the output would be low. One of the drillers is kept to set the drill, and the work for all the women, and another is kept to grind the drills, so that then eight skilled drillers are replaced by ten women, leaving the eight drillers available to obtain the output of forty additional women. The next step in dilution is that the women are watched to find the one showing the most aptitude for the work, and she is encouraged gradually to set the drill and the work under the man's supervision. When she becomes proficient in it she replaces the man who sets for the other women, so that then, without waste of time in training, nine skilled drillers are replaced by eleven women. That is a case of dilution by specialisation of work and nine-tenths of the dilution in the country to-day has been effected in that way. The example he had taken was a single one, but in many cases the re-organisation work required to specialise it and to make it suitable for women was far from simple. Sometimes new methods had to be adopted and sometimes new machines brought into use, but what was always wanted was initiative and ability on the part of the employer. When there was the will to dilute combined with the ability, then the results seen at the exhibition were obtained.

He was dealing at some length with this aspect of dilution, *i.e.*, specialisation, because he believed it had an important bearing on the development of industry after the war. Specialisation, however, was no new thing. It had been a feature of machine shop evolution in the past. In the early days there were mechanics who could see every operation on a job through. Now, in some districts, the apprentice turner would protest vigorously if his employer suggested that he

should do a bit of filing; that was specialisation. Then we now had special machines and special men to operate them. There were millers, planers, shapers and slotters each working their own machines and no other. Lathes had been divided up into centre lathes, capstan and turret lathes and even special makes of lathes, each with its own operator. It was the increasing complexity of engineering work that made this specialisation an absolute necessity, and, in order to get accuracy of work and output from the average man, the man's range of occupation must be strictly limited. Before the war the change was slow and gradual, but the need for dilution had forced the pace, and specialisation had progressed as much in the past two years as it had done in the previous twenty years. We must confess, however, that the point reached had already been attained by American factories. American employers had the incentive of big outputs, and they learned specialisation when large output made the need for it obvious, and, having learned it, they applied it to small outputs. In a few factories in this country, generally under American management, specialisation had been carried to great lengths. There was one extreme instance, the erection of the Ford car on a conveyor. In that work it was one man's job to insert the split pin in the near front wheel axle and it was another man's job to insert the split pin in the off front wheel axle, and specialisation could not go further than that. Generally speaking, however, British machine shops managers before the war had no conception of the advantages to be reaped by specialisation in economy, in output and accuracy of work. Now, dilution had forced them to specialise, often much against their will, but those who could profit by experience would never need forcing again.

What he had said about women's work was, he feared, somewhat derogatory to them. He had emphasised the need for specialisation to make the work suitable for unskilled hands and he had suggested that women were doing the unskilled parts of the work. In nine-tenths of the work that was true, but in the remaining one-tenth it was far from being the case



The aeroplane engine cylinders and the ring and screw gauges shown at the exhibition were done by women who had attained a very high degree of skill, and we must acknowledge the undoubted fact that there are now many women doing work after a few months' training which ordinarily would not be entrusted to apprentices after two or three years' training. In fact, there were now many women who had accomplished what any engineer would have declared to be impossible in the time. The reasons for this were worth looking into. In the first place, the women, if fairly well educated, were much better workers than the boys. The woman was more industrious, more conscientious and more intelligent, and took a keener interest in her work. In the second place, where the work required high accuracy woman had a natural advantage over the male. She had a delicacy of touch that a man could acquire only after long training. That was proved by the fact that in certain jobs requiring extreme delicacy of handling women alone had been found able to do the work. A notable example was that astounding piece of mechanical work, the fusee chain. Some 150 years ago every watch had a fusee chain, which was made by hand, and the fusee chain of a small watch, consisting of some 600 or 800 barely visible parts, appears an impossible thing to make. It was actually made by girls, and he believed it proved impossible for men to make them. The last reason was the most important. It was that the women had been taught, whereas the apprentice was not taught. The apprentice had been merely allowed to pick up what he could and occasionally get a tip from the nearest man when he was at a loss. A friend of his had told him that there was one job he believed he could do better than anyone else in the world because he had spent three months of his apprenticeship doing nothing else, and that was carrying armature coils from the varnishing room to the drying room. That gave an idea of the alleged teaching that the apprentice got. In fact, the apprentice had too often been regarded in the past by the employer as a cheap form of labourer or handyman. Women, however, were a more expensive form of labour, and the

employer during the war wanted output from her and output as quickly as possible, and so he really taught her, and what women had managed to accomplish as the result of this teaching had been quite astonishing.

The dilution of skilled labour did not necessarily, however, mean dilution by the employment of women. Men and boys could be the diluent, and in some occupations they must be. The Ministry of Munitions, however, had always pressed for the employment of women. He said pressed advisedly because in many cases the pressure required had been very great. At the start of the dilution campaign a violent prejudice against women in machine shops was the attitude of most employers. They were ready to dilute with men and boys but not with women. The Ministry advocated women in place of men because men were wanted for the Army or for work which was unsuited for women, and in place of boys because many of the occupations were what were known as blind-alley occupations; occupations in which the boys learned no trade that would be of benefit to them after the war and yet got high wages, which the local police court showed were no benefit to them during the war. At the present time the Ministry advocated women in place of either boys or men over military age because it was found by experience that women acquired skill far more rapidly. He could recall no instance in which a boy or an older man had, after a year's training, reached any considerable degree of skill, but there were many employers now who would undertake to train women in that time for almost any kind of skilled work.

Coming to the present difficulty of the Ministry. Women were already employed on the easier tasks connected with machines for shell fuses and grenades. What remained to be done was to extend dilution to the more difficult repetition work, such as tool setting for shells and fuses, on the repetition work which required high accuracy, such as aeroplane engines and gun parts, and finally on work which is not done in such quantity that women can be confined to a single operation. In all these classes of work certain of the more progressive manufacturers had shown that women can be

employed with complete success, and the work that lay before the Ministry was to induce all firms to comply with the standard set by the few. He had already mentioned some of the difficulties standing in the way. One was that not every firm had the ability to carry dilution very far. That must be regarded as insuperable. Another was that the will to tackle the problem was lacking. This was not generally due to want of patriotism. As a body, British manufacturers had responded magnificently to the calls made upon them in the interests of the country. It was due rather to an honest belief that dilution was impossible or else that it would so decrease the output that nothing would be gained by it. That was a difficulty that could be got over by spreading all over the country the knowledge of what dilution had effected in every class of work, and that was what the dilution officers of the Ministry were endeavouring to do. They had the facts at their command, and their duty was to persuade Jones and Co. to do what Brown and Co. had done. The exhibition at the Royal Colonial Institute and the exhibitions in the provincial centres were another means to the same end. There was yet another means which had not been tried. The position was this. The Ministry had got "the goods" as our new ally would say. So far it had travelled in them and exhibited them, but now it wanted to advertise them, and that was where he hoped the technical Press would give the Ministry help. The technical man had no faith in the lay Press when it touched technical subjects, but he was always ready to study and profit by articles written in his own language by men who knew their subject, and if the representatives of the technical Press would join in this campaign and would study the subject of dilution, he could promise them that they would find it a subject of most absorbing interest, and would find it in their power to give a very great deal of good to the cause.

At this point the CHAIRMAN referred to the considerable number of letters that had been received from various ladies and gentlemen prominently associated with the matter under discussion, express-

ing interest in the meeting and regretting their inability to be present.

Among others, letters had been received from the Prime Minister, the Ministers of Education, Labour and Munitions, Viscount Haldane, Sir Geo. Newman, the Rt. Hon. Arthur Dyke Acland, Sir Robert Blair, Sir James Yoxall, Dr. F. Heath, Mr. Harold Cox, Mr. H. G. Wells, Lady Parsons, Mrs. Sydney Webb, Mrs. Tennant, Miss Mary Macarthur, and Mrs. Garret Anderson.

The Chairman also read extracts from letters from the Rt. Hon. Arthur Henderson and Dr. Chas. Carpenter. The former remarked that the subject was one of such importance and required to be looked at from so many points of view that no message he could send would deal with it adequately. Mr. Henderson also expressed a desire to see a report of the proceedings when issued, as he felt sure that valuable results would accrue from the discussion.

Dr. Charles Carpenter (Chairman of the South Metropolitan Gas Co.), after expressing his regret at being unable to attend, said: "We have gone, I think I may say, at least as far as any gas undertaking in the employment of women in the industry. The surprising thing to me is the manner in which they have adapted themselves to the requirements, or perhaps it would be more correct to say how we have been able to select suitable women for our various directions with which the public is familiar. But we find that they can be trusted with a very large proportion of retort house labour which we invariably in the past associated with the sterner sex."

The Chairman then called upon Miss A. M. Anderson (H.M. Chief Lady Inspector of Factories) to continue the discussion.

Miss A. M. ANDERSON, while expressing her own private views and experiences, spoke nevertheless from the point of view of a responsible officer of the oldest department concerned with the administration of the law relating to factories. That law was the outcome of the last great industrial revolution 100 years ago, and sprang from the urgent need of protecting from injury, first the children

and then the women who were drawn into large-scale production in industry by the wonderful invention of power-driven machinery. In the mere fact of productive labour by women there is nothing new; but before the industrial revolution of the 18th—19th century they worked in England chiefly under the domestic system; during and after it they worked increasingly as independent wage-earners. In the two greatest of their industries, textile and clothing manufacture, they bore their full share of skilled operations. Out of 2,000,000 women and girls in factories and workshops before the war these trades absorbed 1,178,000. In the engineering and metal trades, except in the lighter branches, women played, before the new industrial revolution which began in the events of 1914, only a very subordinate part.

2. In the first stage of the war, before the necessity for the enormous output of munitions was recognised, women played already an indispensable part in keeping the greatly expanding Army and the Navy equipped and supplied in cloth, clothing, metal and fabric equipment, rations, tents, and surgical dressings.

3. Then, in an intermediate stage of the war, came the need for the release of more men for the Army. Early in 1915, at the request of the Army Council, the Home Office and the Board of Trade instituted a series of Trade Conferences of employers and employed to consider how these men could be replaced, either by men of non-military age or by women. The chief problems arose over the suspension of recognised trade union rules and customs, but the conditions of employment suitable for women in new processes had also to be settled. Agreements were secured in a number of trades, including hosiery and other textiles, leather trades, print, bleach and dye works, wood-working, baking, earthenware and china, glove-making, &c. Emergency Orders were made by the Home Office allowing, under safeguards, modifications and relaxations of Factory Act rules; and women successfully undertook work entirely new to them, both in trades for which there were no special agreements and in those where agreements were necessary.

In flour milling, rubber manufacture,

tanneries, oil and seed cake mills, sugar refineries, paper-making, gas works, soap and candle works, cement works, large chemical works where no agreements existed, factory inspectors guided the course of replacement. They asked for and generally obtained, especially from employers in the trades which women had not entered before, welfare conditions necessary to protect them, and they advised as to reorganisation of processes. Both the employers and the inspectors have paid great tribute to the adaptability and natural skill, as well as the patriotic spirit, of the women.

4. In the *third stage of the war* came the extraordinary development in the foremost munition industries, in the engineering and metal trades, the account of which has just been unfolded. The technical and economic aspect of this development has been fully described by Mr. Baillie, but the social and national aspect is equally important. Wide choice of skilled occupations with access to training are good for women as for men, and measures against sudden or long unemployment for women when peace comes are also essential. But it is another thing to try so to organise industry as practically to compel greatly extended employment of women in all great industries. Economic and social ills still remain from the last industrial revolution which might have been averted by earlier recognition of the labourer as more than a wealth-producer.

5. War has shown us plainly that labour is a *social function*, a national concern, that not only its products but its conditions affect the whole community, and that wealth and welfare are in fact interdependent as well as etymologically akin. It is good to know that in great emergencies women can make battleships and guns, or that they can earn men's rates of pay. But not in these things is their best ministry to the life and happiness of the nation. New and wider care of health, especially in infancy, childhood and adolescence, should make claims on women in the future on a scale undreamed of in the past. And though it may be possible to economise woman-power by simplifying the machinery of domestic life, there will still remain women's primary claims of home and

motherhood and the spiritual care of the race. Women, like men, are greater themselves than anything they can produce in the way of national wealth.

Mr. S. R. CHICHESTER (Explosives and Chemical Department, Ministry of Munitions): Mr. Chairman, Ladies and Gentlemen, I am afraid my remarks will be limited to a rather narrow field, as I have been dealing with explosives and chemical factories only. There are, however, some points peculiar to that class of factory which may prove of interest.

When I first undertook this work sixteen months ago my feeling was that there was not much scope for the introduction of women into such places. My opinion, however, has gone through a process of gradual but complete conversion, and I am now convinced that the only limit to the employment of women in such factories is where the labour conditions are such as to place the work beyond a woman's physical strength.

On first approaching the management of firms as to this matter I found they were in nearly every case prejudiced against the proposal by preconceived ideas. Their objections to the introduction of women can be placed under four heads.

1. First, danger—subdivided into (A) danger to the factory, and (B) danger to the women.

1(A). The fears of danger to the factory proved quite illusory. For the delicate operations, of which there are many in an explosives factory women are eminently suited, being more light-handed than men. They can also be relied upon to be just as careful, especially at the present time, when the women can be selected from a far wider field than is the case with men.

A particularly interesting example is the case of one of the filling factories where women are not only employed in all operations in connection with fulminate of mercury, recognised to be about as dangerous a substance as any other, if not more so, but the whole section is under the charge of a woman who told me that twelve months before she had been a nursery governess.

Then, again, a somewhat relevant point in connection with this question is the very small number of women or even the

entire absence of women from those factories where there have been big disasters. It is apparent, therefore, that the employment of women has not tended to disasters of this nature.

1(B). Danger to the women. With regard to the question of danger to the women, this objection is doubtless due to the innate chivalrous feeling of men. But these are special times, and women have shown themselves only too ready and anxious to bear their share. Moreover, the dangers from explosions and poisoning have been very greatly exaggerated and can be greatly mitigated by taking proper precautions.

A particularly interesting case was one at a factory where no women have been introduced on to new operations since the start of the war, and where there was considerable opposition to such a suggestion, and yet at this very factory women have been employed successfully for 24 years on the most dangerous operation in the factory.

2. With regard to the second objection, anticipated moral difficulties, especially in the case of employing women on the night shift. These fears have proved practically groundless. The essential point in this matter is to provide for proper supervision by a female patrol.

3. The third objection is one very frequently urged, to the effect that women were no good in an emergency.

The best contradiction of this was given me recently when, on discussing the pros and cons of the employment of women at a factory where dilution was already very fully carried out, and yet where it was hoped to extend it further, the works manager said, "Well, women have proved themselves better in an emergency than men." This I must admit surprised me. On asking for details to support this view I was told that recently when a fire started in one of the drying stoves all the men in the factory bolted to the office which was in the most remote corner of the enclosure, and stood there at a safe distance and witnessed the foreman, the only man who kept his head, and the women, who were employed in the stoves, putting out the fire. On another occasion in the same factory a small explosion occurred and blew out the side of a

cascade, thereby exposing the furnace. There were no women employed in this section and the men employed there at once cleared out—the one exception being the foreman, who went across and collected the women on the dry-end, who brought their Minimaxes from the drying stoves to the cascade and put the fire out.

In another factory not very far distant from this one there had been several small fires, and the women who dealt with them effectively received a well-earned reward from the manager—the latter's only fear now being that fires are becoming too popular.

4. There is one other objection which managers are apt to raise and that is the lack of confidence in the results if women are introduced.

This is very natural in the case of those managers who have no experience in the employment of women, and there is a special point that arises here in the case of explosive factories that is not present elsewhere, that is to say, that men engaged on particularly dangerous work are very chary as regards their fellow-workers, that is to say, they have got to be satisfied that those working with them are reliable and careful. These difficulties were overcome by collecting in the first instance as much information as possible as to what women had already been able to accomplish in those cases where firms had introduced them to some extent on their own initiative, and, secondly, by endeavouring to get matters so arranged that women were always put first on to the simpler, safer operations, and thereafter a selection made for introduction to the harder or more dangerous work.

There are certain disadvantages in the employment of women. First, from a woman's point of view, work in a factory gravely interferes with home life. Moreover, the eight-hour shift, except in those cases (which are naturally absent in war-time) where only one shift is worked, has not proved the remedy that might have been anticipated owing to the fact that times of coming and going do not fit in so conveniently as those of the twelve-hour shifts.

The sole disadvantage urged by firms who have given the policy a fair trial has

been that women are less regular in attendance and that, therefore, a larger proportion have been kept on the books than is the case of men. There is no reason, however, why the total pay should not be the same in such cases.

On the other hand, women have undoubtedly shown themselves keener, more readily adaptable, to changing conditions.

An interesting point is that their keenness does not appear to wear off with the novelty of their situation.

I have also frequently found cases where the women have been willing to face far more adverse conditions than the men. They have carried on through rain or snow, when the men have knocked off work. A particularly interesting case of the efficiency of women is one of a factory where at the time of my first visit no women at all were employed, and the suggestion that they should be employed was met with considerable hostility. In due course, however, they were introduced fully on to all operations on the dry-end, which, in the case of this factory, was the most dangerous end, and I then approached the manager with a view to getting them put on to the whizzing. He was not at all favourably inclined to this course at first, thinking that the loads the women had to carry were too great and that they would probably smash up his whizzers, which are costly and difficult to obtain at the present time. But, to cut a long story short, it proved possible not only to remove every man from this operation and run the work entirely by women, but they did the work so efficiently that the night shift was eliminated, although the production was in no way reduced thereby.

I have just one further point of interest, and that is the comparative immunity of men and women from the poisonous effect of various chemicals which they have to handle. This is a highly controversial matter, and I do not think that any decision has ever been arrived at, or is likely soon to be arrived at, but there are three points distinctly in favour of women:—

(1) They keep themselves cleaner.

(2) They are less given to the consumption of alcohol and therefore less likely to absorb these poisons.



(3) Where women are employed the hours worked are generally shorter.

There is also one other point which seems to me possibly favourable to women, though I have no medical authority to make a definite assertion, and that is, women perspire less freely than men, and so perhaps do not absorb poisons so readily through the skin.

As against this, women are inclined to take insufficient meals. A rather amusing case in point was at a filling factory where T.N.T. was handled. It was found that the women brought a bun in a bag with them and transferred the bun to the pocket of their overalls, and in the course of the morning were perpetually feeling for this bun to assure themselves that it was still there, and about mid-day had a meal of bun and T.N.T.

As regards results attained. It is a little difficult to give definite figures because you may have two factories making the same product but owing to differences of geographical position and type of plant, what is possible in one case may not prove possible in another. The locality, type of plant, and class of female labour very materially affect the result. The best dilution, however, that has been attained in the case of the chief explosives is approximately:—

Cordite, 54% of total employees are women.

Picric, 40% of total employees are women.

Filling, 93% of total employees are women.

This last was in the case of a factory where there were a good many small operations such as fuse work, &c. On the other hand, the high figure of 89.9% has been reached in a factory dealing exclusively with fairly large-sized shells.

Women are, moreover, performing all operations in the manufacture of gun-cotton and T.N.T.

To sum up, I think that the policy of dilution has been thoroughly justified by results to date, and though it has reached a stage which I for one never anticipated, I think there is still ample scope for further extension.

Miss O. E. MONKHOUSE (Chief Woman Dilution Officer, M.O.M.), mentioned a

few points bearing on the efficient employment of women apart from the technical aspect of the actual work carried out. Shop organisation was of the greatest importance in the successful employment of women; defective shop organisation had been the cause of certain failures to employ women efficiently. As an instance, a foreman appointed because of his ability to manage men was not necessarily a good foreman for women. Men generally were either too lenient or too stern with women, and although the women on occasions had refused to have a forewoman, yet it was found the best results followed from the adoption of this policy. Men were not asked if they would have a foreman and women should not be asked if they would have a forewoman. As to the type of women labour, apart from the repetition work, there was great need for women of better education and who had had some shop experience to deal with some of the non-repetition work. Also women who could hold their own in the shops to act as forewomen and charge hands. As an example of what can be done with women labour, she mentioned the case of a 9.2 shop which was quite unable to make any headway with women labour. The Ministry of Munitions sent down a woman officer, and in two months she reorganised the shop, put in women charge hands, and discharged about 30 per cent. of the women who were found unsuitable, with the result that the shop was now running very smoothly. The last point she wished to mention was the means adopted by the Ministry to help manufacturers to employ women. If firms had any difficulty in handling women labour, they were urged to apply to the Ministry for assistance where they could have the benefit of a trained organiser and also the benefit of the accumulated experience of the Ministry. Dilution officers would be placed at the disposal of firms to give advice and assist generally as to the best methods to adopt to employ women successfully. The difficulty at present was that firms did not apply until they had paid the price of experience and experiment. It must be understood that these officers did not offer advice based on their own limited experience, but on the experience of the Ministry in

dealing with this subject all over the country.

Mr. ATTWOOD was emphatic upon this matter of dilution. His experience in many types of factories proved conclusively that women could be brought into our factories with excellent results provided the change over was brought about in a properly organised way.

Some employers rather shirked the problem because it meant increased trouble to them, or from the old idea that a woman could never be as good as a man, and in any case she could not possibly learn in a few weeks what he imagined it had taken the man years to acquire.

In practice all this has been found to be false. Where this matter of dilution has been faced squarely, and means sought to solve rather than magnify the problems, the company itself has derived benefit which it did not anticipate. The very fact that many of the operations had to be carefully studied in order to find out, firstly, whether they would be suitable for women, and secondly, just what was the easiest and quickest way of teaching the new-comers, brought to light many things which had escaped notice in the past. It gave many a factory manager a real insight into the possibilities of the various types of work, and he accumulated experience which will be of inestimable value when the men return once more to bench and lathe.

Where a correct study has been made of the tasks undertaken by women and proper arrangements made to train them in correct work habits, there is not the slightest doubt that they are able to carry out much of the work of men who were released for the Forces; in fact, they have done better than these men who had been allowed to jog along on "rule-of-thumb" methods.

If it has not been customary for women to work in certain factories, then their introduction brings along some new problems; but they can be overcome, although it must be borne in mind that the psychology of the woman worker differs from that of the man. However, there is a big advantage on the side of the woman, in that she is not at present

handicapped by the industrial evolution through which the man has passed. The woman is looking to the future, the man has also to safeguard the inheritance gained from his past struggle.

Women workers will be found to be loyal to the management and willing to co-operate with it. They have a fine sense of justice, and so long as they are governed fairly and tactfully they give of their best. Most women will prefer another woman as their immediate supervisor, although it is well for a man to be in the background, as it were. He will be looked to as the supreme authority—for it must not be forgotten that women still look to men to take the lead. It is nothing short of remarkable to see how a group of women workers will strive to come up to the standard set them by the factory manager, when they feel that he is directing them wisely and well.

The speaker called to mind the special case of a group of women workers in a factory in Lancashire. The Government made a special request for a certain commodity in numbers much in excess of the usual output. The various subdivisions of the work were studied, the women were carefully instructed during factory hours on the best methods of procedure and in one month the same number of women increased the output threefold, their rates of pay went up 50 per cent., and the cost was reduced in the ratio of 8 to 6. Probably most employers would have increased the output by increasing the staff, but in this case the extra plant necessary for additional workers was not available, and a scientific investigation, brought about partly by necessity, found that the possibilities of the task had by no means been exhausted.

A further instance was interesting. A certain task was carried out by men in pairs. As the work was highly important it seemed at first that both men were necessary for the job, but investigation proved that one man did the highly specialised operations and the other did merely mechanical work. It was obviously quite simple to get women to carry out the easier operation and so release 50 per cent. of the men. These women were able, in a few days, to deal with their portion of the work just as efficiently as the men used to do it. But care had to

be taken to train the women. It is very little use letting the women just float into the men's jobs and pick it up in much the same way as the man probably did. Someone must show her just what to do, how to do it, and then be prepared to direct her carefully and tactfully until she has acquired the correct work habits. This is nothing like so heavy a task as many imagine, and whatever trouble is taken is amply repaid by the result and the feeling that the country is being helped too. Many employers to-day are reaching out for newer and better ways of dealing with their employees. Those who have tackled this problem of dilution in the right spirit have, quite unwittingly, discovered ways and means of bringing their ideas along this line into practical shape.

A speaker here remarked that there were already in existence, in a small way, many businesses such as mills, laundries and clothing factories, where not only all the operations but all the skilled management was in the hands of women. In a case she had in mind, a convent, even the boilers and engines were attended to by women, and all the workers appeared contented and happy.

Mr. S. J. SEWELL (Hon. Secretary, London District, Inst. of Journalists) expressed his appreciation of the remarks of Miss Anderson and his interest in Mr. Baillie's address. It seemed desirable for the Ministry of Munitions to make clear the aims that they had in view in regard to the employment of women. The term "dilution" had never seemed to him a wise one, and did not properly express the methods which Mr. Baillie had explained in the course of his address. "Systematisation" would be a better word. Dilution was an offensive phrase to many workers. He was inclined to think that a good deal of labour troubles had been caused by not making it sufficiently clear that the practices of the Ministry had been designed for the purpose of meeting the extraordinarily difficult conditions at the present time, and therefore must be considered as an emergency measure.

When the war was over we wanted the skilled workers at the front to come back

and find their places open, and not taken by women. He himself lived in an agricultural village about 28 miles out of London, where there were 32 girls, previously employed in unskilled labour locally at 12s. 6d. a week but now earning from 35s. to 40s. a week in a munition factory some eight miles away. What was going to happen to such girls after the war?

He thought it should be clearly recognised that the present conditions were exceptional and not to be perpetuated, and that after the war our efforts should be devoted to ensuring that women labour was more and more applied to those industries which become women, rather than to work better suited for men, but which, in the nation's interest, many thousands of women were now undertaking.

Mrs. ARTHUR WEBB said that she wished someone like Lieut. Atwood would go round and try to persuade the farmers to make fuller use of the services of women. The farmer was quite willing to take women after they had been trained, but they would not undertake the training themselves, and it needed a great deal of persuasion to induce them to change their methods, and receive instructions as to how the training should be carried out.

Miss J. COOKE (Ministry of Labour Employment Dept.) said that the supply of woman labour was also one of considerable interest in any arrangements for dilution. In many cases it had been found necessary to transfer large numbers of women to munition areas, and the work of the Employment Exchanges had been considerably increased in this way. Great difficulties had often been experienced in persuading women to leave their homes to work in other districts, and until a connection had been established with a certain factory, so that friends and relations could go together, it was almost impossible to persuade countrywomen to migrate.

Where large munition works exist, and in consequence numbers of women have had to be brought into the area, Local Committees had usually been set up by the Ministry of Labour and the Home

Office. These Committees were usually chiefly concerned with the question of lodgings, the Secretary keeping a list of inspected lodgings to which the girls from a distance could be sent on arrival.

In one case, among others, over 1300 women had to be housed in the West of London within a month. The Committee had also frequently undertaken outside recreation, clubs and general welfare work.

At this stage the Chairman stated that the time available for discussion was nearly exhausted and expressed the hope that any present who wished to take part would send in their remarks in writing.

Captain SCOTT-HALL (*communicated*):—

It cannot be questioned that we are living in an epoch-making age, and when the history of the war comes to be written, the part that women have played will form no unimportant chapter. They have helped us to overcome the shortage of labour in a most unexpected manner, and have proved themselves capable of work which, before the war, we should have hesitated to believe it possible to entrust to them.

It has been my privilege during the past eight months to work in an explosives factory, in which 3,500 women were employed. Let me describe some of the operations undertaken by women; I will begin with the Gun Cotton Section.

Here, we have women handling the cotton waste from the moment of its arrival at the railway siding. They unload the trucks, handling the heavy bales, weighing from 5 to 6 cwts., by means of overhead runways, distributing them to the bale breaking room, where other women take them in hand, removing the iron bands, and placing the cotton in the bale-breaking machine. They are engaged in the teasing room, superintending various operations, including the drying. They haul the cotton to the nitrating house by hand, and perform all these operations under the charge of forewomen, and without the assistance of men. On its arrival at the nitrating house, they place it into pans, and carry out the dipping, a process somewhat difficult for women, owing to the nitrous

fumes issuing from the pans. At this stage they wear respirators. From the nitrating house by means of more overhead runways, they distribute the nitrated cotton to the vat house, where they undertake the boiling and washing. The next stages are the breaking up of the gun-cotton into pulp by machinery, working the pressing machines, and finally packing in boxes. Here the assistance of men was required in removing the heavy boxes to the magazines, but a scheme was set on foot shortly before I left which will enable even this work to be done by women. So from start to finish in the manufacture of gun-cotton, each process was undertaken and carried through by women, with the oversight of the chemist in charge.

Women were also employed in the boiler house. It is true that there were mechanical stokers, but at times women did raise heavy shovelfuls of coal, shoulder high, and feed the boilers. Women control the feed, watch the temperature of the feed water, and attend the boilers generally. The general labouring was done by women, who rake out the hot and heavy clinkers from large and exceedingly hot furnaces, wheeling away heavy loads of clinkers, and depositing their loads on the dumping ground outside; in short, doing work which, before the war, was universally considered men's work. Not only do these women carry out the work satisfactorily, but what is more, they like it, and even prefer it to the lighter work in other parts of the factory.

I might here mention that the type of woman was not that of the sturdy Yorkshire class. On the contrary, they were small and even diminutive, and yet quite capable of coping with the heavy work of the boiler house.

On the Acid Plant, they took their place, receiving the soda on its arrival in trucks, unloading and distributing to the kilns, and afterwards charging the retorts, placing the earthenware cover over the opening, and cementing it as well as any man ever did. They had charge of the stills, taking the tests and generally superintending the plant with the assistance of one foreman and one chemist in charge.

We next come to the manufacture of trinitro-toluol. A considerable amount of care and discretion is required throughout as the turning on of the wrong tap would easily end in disaster; but, in the opinion of one of the chemists who has had long experience in the manufacture of explosives, women are better fitted for the work than men, owing chiefly to their patience and perseverance. In the packing room they wear respirators to prevent them inhaling the dust from the dry trinitro-toluol as they weigh it and place it in bags, preparatory to its despatch in boxes. Here, again, girls screwed down the lids of the boxes in a most business-like fashion, and finally wheeled the explosives away in trucks to the magazine adjacent to the railway siding.

I should next mention the box factory, which consisted of six separate machines, all operated by women. In the first, the wood was planed, in the second, tongued and grooved, in the third, four sides of the boxes were mechanically pressed together, in the fourth the rough edges of the boxes were planed off, in the fifth the bottom of the box was nailed on by machinery, in the sixth the holes in the lid of the box were drilled to receive the screws. There was one man foreman in this box factory, and several women charge hands. On one occasion the foreman unfortunately caught his arm in the belting, inflicting very serious injury, and the only other man present at the time ran off for the doctor, but one of the women standing by at once removed some of her clothing and bound up the man's arm, until he could be taken to the dressing station. This, you will agree, showed great presence of mind on the part of the woman, and a total absence of the timidity often attributed to women in the face of danger.

To sum up generally, I might perhaps say that the women in this factory were sensibly clothed, discarding their skirts for trousers and short coats, made of warm material in winter, chiefly khaki colour, and in summer light dungarees and different coloured caps to show the sections to which they belonged. They do not object to the garments; on the contrary, they are of opinion that they are better able to do the work in them than in skirts.

Mr. A. P. M. FLEMING (*communicated*): The diminution of man-power due to the war has not only affected the rank and file of workers, but has also depleted the highly trained staffs in industry. While effective steps have been taken to employ women substitutes for machining and manual operations, comparatively little organised effort has been attempted towards their employment in positions hitherto held by men of professional training. In the engineering industry there would appear to be scope for educated and specially trained women, and although for such purposes as analytical chemistry and research women have found employment, very few have entered the ranks of technically trained engineers.

To make up for the depletion of staff due to the war, the engineering firm with which the writer is connected considered carefully the employment of educated women for such work as technical calculations, drawing, electrical testing, technical correspondence, technical publications, and scientific research. It was realised that for all these functions some specialised instruction would have to be imparted, over and above the university or other education that the candidate had obtained. To carry this scheme into effect, a number of university and good secondary school students were selected and placed in departments relating to these different classes of work, and at the same time some eight hours per week specialised instruction was given during working hours in subjects relating to everyday work. Due to the probability that only a few such women will stay in industry all their lives, the character of the training aimed at making them specialists instead of all-round engineers. During the past twelve months upwards of sixty women have been selected and trained in this way, and thus far the results are satisfactory.

In view of the fact that for some years to come the supply of technically trained men from the colleges and universities will be very small, it is to be expected that women thus trained will establish themselves permanently in the higher positions in industry, and will be an important asset when the time comes for



keen competition for the world's markets after the war.

Mr. J. S. Dow (*communicated*):—The position of women in industry after the war will be a very important problem. It seems to be generally agreed that their employment for heavy and taxing varieties of work should be regarded as only a temporary expedient. After the war their assistance will doubtless be diverted into fields best suited for their natural gifts, and it would lighten the difficulties of the coming transition period if these special fields of work could be thoroughly surveyed beforehand. Light agricultural, horticultural, and dairy work, clothing and textile industries, the making of electric lamps, incandescent mantles, and optical and scientific instruments have been mentioned as suitable employments. In many sections of engineering work the fine operations requiring delicacy of touch might be allotted to women. Such work should be sectioned to avoid overlapping of male and female labour.

We must look to the new industries which we hope will develop in the future to provide new channels for the employment of women released from munition factories.

The idea that women are only to be relied upon to do all the tedious and routine work, leaving the more interesting and constructive work to men, will also have to be abandoned. The war has banished many misconceptions regarding the limitations of women. Although domestic duties will naturally be a bar to many responsible positions where continuity of service is vital, there will nevertheless be many opportunities for educated women. I have always held the view that women could do a great deal to provide the rank and file of scientific workers, sadly lacking in this country in the past. In such work their peculiar patience, neatness, digital dexterity and attention to detail would often be valuable. A short time ago I heard an encouraging account of the use of women in a factory where very intricate chemical analysis of the rare earths was being done. Here the qualities referred to above were strongly in evidence, and in several cases there was initiative as well.

The line from Tennyson's *Princess*, "But when did women ever yet invent?" has often been quoted against women. It might be added, "When did women ever have the opportunity or inducement to invent?" In this sophisticated age it is apt to be forgotten that necessity is the mother of invention, and that the latent originaive faculty is only aroused by suitable education, training, and subsequent responsibility.

The training of women for specific vocations is one of the most important problems for educational reformers to consider and even in the present circumstances the ground might be surveyed as a preliminary to future action.

Miss A. A. SMITH, in a written communication, expresses her regret at being unable to be present at the discussion, and refers to the good work being done by women in engineering shops at Plaistow. This is also one of the few districts in which women are driving electric cars. They have acquitted themselves well in this work, and the Corporation is engaging an increasing number of women drivers.

A vote of thanks to Mr. Baillie and the other representatives of Government Departments who had taken part in the proceedings was moved by Mr. GILBERT WOOD, and seconded by Miss L. E. PATTERSON (Chairman of the Women's Sub-Committee).

Mr. GILBERT WOOD, in proposing a vote of thanks to Mr. Baillie, mentioned the treatment of apprentices referred to briefly by Mr. Baillie. He had for many years felt very sadly on this question of apprenticeship; there was no doubt that under the old-fashioned apprenticeship the boys were not always very kindly treated. Laws had to be passed to protect him, but there were also penalties which were enforced against the apprentice if he did not carry out his work properly. He would be very sorry in the present state of labour in this country and the magnificent work we generally had from labour, and the splendid co-operation of the union leaders during the war, to say anything that could possibly be supposed to hurt their

feelings, but the fact was that the apprenticeship system had been largely killed by the trades unions. It had been suggested that the employer would be glad if the apprentice always remained an apprentice at 7s. 6d. per week or something like it. That had not always been the case, and he had known many works where it had not been the employer's view in any sense of the word. It was the trades unions that objected to the apprenticeship system, not perhaps officially, but some members occasionally adopted a system, by which the apprentice instead of being taught his work, was initiated into the limitation of output, and some other undesirable ramifications of present-day trades union principles. The hopes of the future of this country's prosperity will largely turn on the question of our ability to show the quality of our craftsmanship, and the quantity of our output, and a loyal understanding between employer and

employee. In proposing this vote of thanks to Mr. Baillie, I should like to include the names of those ladies and gentlemen who have been present to-day, and who have given us such satisfactory and interesting accounts of their experience of women labour in our works and factories.

Miss L. E. PATTERSON, in seconding the vote of thanks, said that she had listened with interest to the discussion, but would like fuller information as to the prospects of women now engaged in munition work after the war. She had been somewhat surprised at the continued demand for women's services in war work, and it was very important to know what opening there would be in the future for women in the industries they were now entering. Many of them would not be content to return to their old dull and useless lives.

The discussion was terminated by a vote of thanks to the Chairman.

#### EXHIBITION OF WOMEN'S WORK AT LEEDS.

The series of exhibitions of women's work that is being arranged by the Technical Section of the Labour Supply Dept. of the Ministry of Munitions was continued by an Exhibition, at the City Art Gallery, Leeds, of Samples of Women's Work on July 9th.

The exhibit consisted both of examples of work actually made, and of photographs of women making them, and was divided into fourteen groups.

A great variety of work was shown, including engines for aircraft, motor-cars, and "tanks," steam engine parts, gauges and dies, cutters and test-pieces of various kinds, small parts of Lewis and Vickers machine guns and Lee-Enfield rifles, and projectiles. A specially interesting section was that devoted to optical munitions and glassware such as gun-sights, periscopes, binoculars, range-finders, etc., the instruments being shown in all stages of manufacture, from the rough glass upwards.

#### PERSONAL.

At the Annual Meeting of the Royal Society of Arts on June 27th a cordial vote of thanks was proposed by the Chairman (Dr. Dugald Clerk, F.R.S.) to Sir Henry Trueman Wood for his work as secretary of the Society during forty-five years. Sir Henry, after this long period of distinguished service, has intimated his intention of resigning next September, when he will be succeeded by Mr. G. K. Menzies, who has been Assistant Secretary since 1908.

Mr. Charles F. Lacombe, who has been in practice as a consulting engineer in New York for the last few years, and was formerly Chief Engineer to the Dept. of Water Supply, Gas and Electricity in that city, has accepted a commission as Captain of Engineers in the Second Provisional Regiment 15th Co., at Plattsburg, N.Y.

Mr. Lacombe is well known to our readers as an expert in street lighting, and his professional experience will doubtless be of considerable service in his new work.

## INDUSTRIAL RESEARCH IN THE UNITED STATES.\*

By A. P. M. FLEMING.

THIS paper is the first of a series to be issued by the Advisory Council on Industrial Research. Mr. Fleming summarises his observations during his



Fig. 1.—The Mellon Institute of Industrial Research, containing upwards of 30 laboratories and employing about 70 salaried research workers.

recent visit to the United States, a useful feature being the inclusion of a number of reproductions of photographs of typical American laboratories and institutions. A number of suggestions are also made for the development of industrial research in this country.

Industrial research in the United States may be classified according to whether it is undertaken by: Manufacturing Corporations (companies), Associations of Manufacturers, Universities and Colleges, National Institutions, Commercial Laboratories, and Scientific Societies.

The Report contains a brief description of 21 industrial research laboratories, 13 examples of University Research, 6 National Institutions, and 7 Commercial Research Laboratories. In many cases the expenditure on research work is very considerable. Thus the Eastman Kodak Co. spends for this purpose about £30,000, or 0·7 per cent. of the annual profits, and the General Electric Company from £80,000 to £100,000 per annum.

\* To be purchased through any Bookseller or direct from H.M. Stationery Office, Imperial House, Kingsway, London, W.C.2; 1s. net or 1s. 3d. post free.

Among the most striking features of the research work undertaken are:—

(1) The installation in many cases of full scale manufacturing facilities which enable works to be relieved of experimental development, and ensure that inventions can be tested on a practical scale before manufacture for sale.

(2) The provision of facilities to enable any new discovery in the works to be taken up at the stage in which the scale of manufacture calls for transference to a separate organisation.

(3) The tendency to devote more time to pure science investigations, such as may ultimately lead to new discoveries.

Other points of interest are the freedom with which results in pure science are published; the growing appreciation of the value of scientific men in the factory; and the recognition of the value of research laboratories as a means of inspiring confidence in the minds of customers. There are a number of

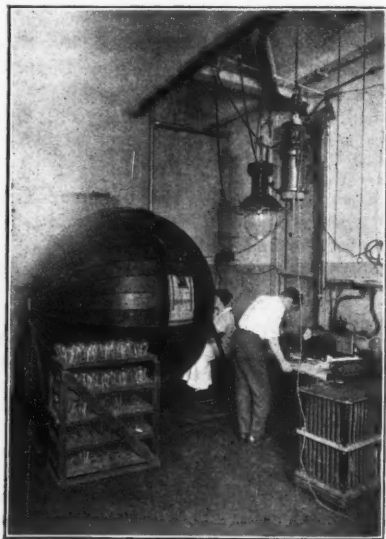


Fig. 2.—Lamp Testing Laboratory, Electrical Testing Laboratories, New York (U.S.A.).

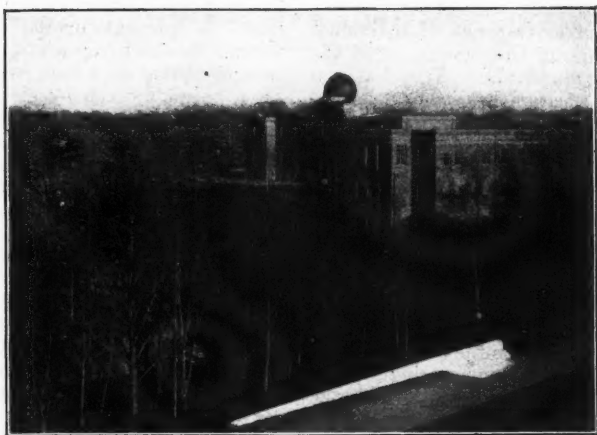


Fig. 3.—General view of Laboratories and Park, National Electric Lamp Association. This Association, which is controlled by the General Electric Co. (U.S.A.), comprises twenty or more electric lamp factories in the States. There are seven large blocks of buildings, situated in a park of 79 acres, and about one-third of the buildings and staff (numbering 600) is devoted to research. The Laboratory includes a full-size manufacturing plant for producing lamps in bulk.



Fig. 4.—Research Building, General Electric Co., U.S.A. The Research Laboratory occupies the first five floors of this seven-storey building. The annual cost of research work conducted is now about £80,000—£100,000, and a staff of upwards of 150 is employed on experimental work.

Associations of Manufacturers which conduct research work of common benefit, either in the laboratories of individual manufacturers, in Universities, or at the Bureau of Standards. The National Canners' Association has its own laboratory.

At the Universities fellowships are often endowed by firms or scientific societies, and large-scale investigations are undertaken at experiment stations. The Mellon Institute is unique. It contains about 30 laboratories where work is carried out for manufacturers, who are required to endow fellowships for men undertaking the desired investigations. When a research nears the practical stage plant on a small manufacturing scale is often installed in order to develop the process fully before it is attempted on a commercial scale. Results of such researches are not published, except with the consent of manufacturers, until three years after the investigation.

The National Institutions, such as the Bureau of Standards, the Carnegie Institution, the Forest Products Laboratory, and the Bureau of Mines offer extensive

facilities for research and their advice is freely given. Attempts are now being made to prevent overlapping of the various Research Agencies. It is widely recognised that important researches may often be undertaken by men of average ability working under competent direction. This is a point that is insufficiently appreciated in the United Kingdom.

Turning to conditions in this country, Mr. Fleming points out that the war has disclosed remarkable latent capacity for adaptability to new lines of manufacture, many of them dependent on scientific research; but the facilities for such research are at present disproportionately small.

The most important alternative schemes for the United Kingdom, as suggested by Mr. Fleming, are:—

(A) Research Laboratories in industrial works.

(B) Research Laboratories for a group of works in the same industry.

(C) The centralisation of research in the Universities and Colleges.

(D) An Imperial centralised laboratory for the whole industry.

## DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH.

### New Address.

From July 23rd onwards the Offices of the above Department were transferred to 15, Great George Street, Westminster, S.W. The telegraphic address ("Resciendus Parl. London") and the official telephone number (Victoria 7940, 2 lines), remain unchanged.

## Obituary.

The death is announced of Mr. William Wilmot, who had been associated with Messrs. Falk, Stadelmann and Co., Ltd., for the last 16 years.

Mr. Wilmot recently joined His Majesty's Forces, and while on duty contracted pneumonia which unfortunately proved fatal.

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Particulars on receipt of post card at either of the above Offices.

F. NORIE-MILLER, J.P.  
General Manager.



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## CORRESPONDENCE.

## FLUORESCENCE AND PHOSPHORESCENCE.

June 11th, 1917.

SIR,

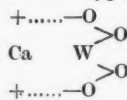
The discussion and papers on "Fluorescence and Phosphorescence" in your March issue gives a valuable review of the physical and engineering aspects of the subject. If a photochemist may be permitted to indicate the chemical basis of the phenomena, I should like to submit a few considerations tending to the conclusion that fluorescence and phosphorescence do not simply denote a "distinction without a difference," but the time-lag in the latter has a chemical cause. Naturally in the scope of a letter I cannot enter into all the evidence, but I would point out that whilst *fluorescence*, in the sense of luminous or actinic response which terminates at once when the exciting rays cease, depends conjointly upon the chemical composition and constitution of a saturated pure compound, *phosphorescence*, response persisting subsequent to excitation, is associated with the presence of stray or unsaturated affinities due to free, usually metallic nuclei, of several valency stages, in colloidal or solid solution in the material.

This conclusion is not, of course, new, but was established by the work of Lecoq de Boisbaudran, and confirmed and extended by Lenard and Klatt, working on alkaline earth sulphide phosphors. I have obtained evidence in the same sense working with calcium tungstate, which can both fluoresce and phosphoresce under X-rays. Briefly:—

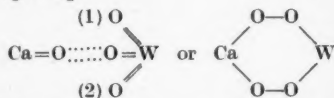
(1) Calcium tungstate precipitated in the wet way and dried exhibits neither fluorescence nor phosphorescence. This precipitate is visibly amorphous, but under high power microscopic examination seems to be microcrystalline.

(2) Fluorescence and phosphorescence, to X-rays, are developed by heat treatment carried to the "sintering" point, when the material consolidates from a loose voluminous powder to a dense solid and becomes pronouncedly crystalline. It appears from this, and from other cases cited by your contributors, that the luminous response depends largely upon the development of the crystalline solid structure, but the more exact nature of the dependence will require special "crystal analysis" on the lines due to Laue and the Braggs. It seems possible, provisionally, that the most precipitated calcium tungstate formed by combination of the ions,  $\text{Ca}^{++}$  and  $\text{WO}_4^{--}$ ,

consists chiefly of a *polar* compound, a "tungstate," of the type



more or less hydrated, owing to the half-free charges, and that this is metamorphosed by the heat treatment (to incipient fusion) to an anhydrous *non-polar* complex of the type  $\text{CaO} \cdot \text{WO}_3$  or  $\text{CaO}_2 \cdot \text{WO}_2^*$



which, singly or in group molecules united by the residual affinities of the oxygen atoms (1) and (2), form the structure units of the crystalline configuration in the denser, luminescent form. In view of the variety of combinations of the oxides of tungsten with more basic oxides, the displacement of the system either to more basic tungstates or to more acid (polytungstates) is easily possible, and must play a part in affecting both the crystalline solid configuration and the luminescence.

(3) Be that as it may, the elimination of *phosphorescence* from a calcium tungstate in X-rays, and restriction of its response to *fluorescence*, depends upon the purity and purification of the material, in particular, on the removal of *reducing* materials and conditions. It is easy to prepare tungstates having considerable amounts of the tungsten present either as a sub-oxide  $\text{WO}_2$  or more probably as colloidal tungsten—the "tungstate bronzes" are examples of such bodies—and our work indicates that all circumstances, tending to produce this partial reduction favour strong phosphorescence, and conversely. The amount of reduction product necessary to induce marked phosphorescence is extremely small, probably in the order of the "latent image" in photographic plates, and, again, with the production of visible coloration (bronzing) of the tungstate, the phosphorescence reaches a maximum or even becomes less.

Trusting that a chemical after-glow on one phase of this subject may not be unwelcome, I remain,

Yours very truly,  
(Dr.) S. E. SHEPPARD.

(Eastman Kodak Co., Research Laboratory, Rochester, N.Y.)

\* As found in rutile, zircon, etc.

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